

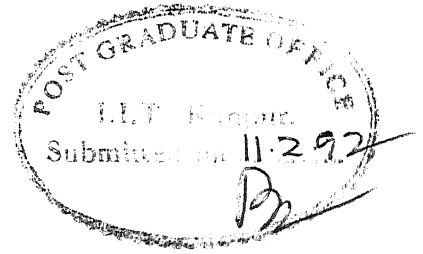
AN EXPERIMENTAL PC BASED MULTIMEDIA DATABASE MANAGEMENT SYSTEM

*A Thesis Submitted
In Partial Fulfilment of the Requirements
for the Degree of*
MASTER OF TECHNOLOGY

by
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to the
**DEPARTMENT OF INDUSTRIAL & MANAGEMENT ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY KANPUR**

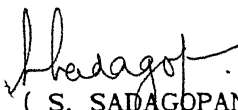
FEBRUARY, 1992



CERTIFICATE

This is to certify that the present work on "*An Experimental PC Based Multimedia Database Management System*", by *Vishwas Deep* has been carried out under my supervision and has not been submitted elsewhere for the award of a degree.

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ABSTRACT

In the present work an attempt has been made to develop an experimental multimedia database management system. The media included are of two types, alphanumeric and bitmapped graphics. The experimental system can handle three different data-types, a character string, an integer and a bitmap. Both data definition and data manipulation steps, have been fully implemented.

The package uses Borland c++ and Windows 3.0 and runs on 386 based hardware platform. To create the bitmap from the paper media a scanner is also needed. The manipulations like addition, deletion and modification of fields as well those of records are done in DOS environment; While the display of records and query on records is performed in Windows environment. An intuitive visual interface is used for querying the database. The contents of every graphic field are shown in a separate Window. These Windows can be resized, zoomed or iconised depending on the user requirement. All the functions are performed with menus, dialog boxes and message boxes, with the user interaction primarily through a mouse.

The package developed was found to be very instructive and gives the user a flavour of the multimedia database systems.

INTRODUCTION

1.1 MANAGEMENT AND INFORMATION :

Management is the art of planning, coordinating, deciding and control of the various activities of a concern. Decision making forms an integral part of the management. Information that aids decision making, naturally plays a significant role in management. The means of gathering the information however have changed with time. Earlier information used to be acquired by plain observation or through oral communication. But with the passage of time the quantum of information required by the management have significantly increased. Accordingly in modern times information is gathered by sophisticated computers. The management's view about the information is also undergoing a significant change over the past few years. There has been a revolution in the structure and management of information systems that collect, store and disseminate organisation-wide information.

In the past information was considered a necessary evil associated with the bureaucracy. Information was viewed as a 'Paper dragon' that could potentially strangle the firm and prevent it from doing the real work. By the 1960s the concept of information had changed [10]. It was recognized that information could provide general support for an organisation. Information could provide insights: for example, reports on weekly production, monthly financial flows, inventory, accounts receivables or accounts payables. The concept of managerial information was once again changed in the 1970s and early 1980s. Information became a tool to aid management in providing a fine-tuned, special purpose and customized control over the organisation. Today leading companies and organisations are using information technology as a competitive tool to develop new products and services, forge new relationships with suppliers, edge out competitors and radically change their internal operations and

organisations. In other words we are witnessing an information driven management of organisations.

1.2 INFORMATION SYSTEMS :

An information system according to International standardisation organisation, ISO [27] is a predictable system for keeping and manipulating information, of components responsible for the transmission and processing of information, for the benefit of some recipient, in the context or environment that it was designed to support. An information system can be implemented anywhere along the scale from fully manual to fully automated or computerised.

Let us consider a very small information system i.e. an address book. It is a very simple information system which provides the user with names, addresses and telephone numbers of friends. The components of this system are following:

- (i) An information storage device which is notebook or diary in this example.
- (ii) Encoded information, expressed as symbols of some language such as English.
- (iii) A collection of processing functions :
 - (a) Addition of entries.
 - (b) Modification of entries including deletion.
 - (c) Retrieval of information in a variety of forms.
 - (d) Inference of information.

This example illustrates a number of characteristics of an information system; As the amount of information increases the manual information system becomes too much time consuming to provide flexible access to accurate, timely and useful information to end-users. For that computer based information system comes to our help. In the modern society

for managing a manufacturing concern, a commercial center, a research organisation or an educational institution the computerised information system plays a very significant role.

1.3 DATABASE COMPONENT OF INFORMATION SYSTEMS :

The database component of an information system is the subsystem that is responsible for the storage, retrieval and maintenance of information for the benefits of other system components. It is some information storage repository, with associated procedures for encoding and decoding information from the stored representation and for providing access to that information for various purposes. A poorly designed database may fail to provide the required information or may provide outdated, flawed, or contradictory information. Naturally a good design of the database component is a fundamental requirement for the success of any management information system.

1.4 DATABASE :

The database can be considered from many points of view. This poses a problem in defining a database. Two possible viewpoints are as follows:

(a) Physically, a database is a number of bits recorded on some storage medium [7].

(b) Semantically a database is a representation of some universe of discourse [7].

Additionally we can consider definitions from other points of view as well:

(c) From the point view of an organisation's manager a database is an expensive and valuable resource that must be managed effectively and exploited to the fullest extent.

(d) From the point of view of a programmer, a database might be a collection of record types and navigational paths.

(e) From the point of view of users, a database is a source of information.

A third approach to definition of database is to take a machine's view and to say that :

(f) A database is a collection of files; database files containing actual data and system files containing system information like schema and indexes for efficiency of access.

After analysing these definitions a general purpose definition for database seems to be an "integrated self describing repository of data" [7].

Data item is the smallest unit of data that has meaning to its users [3]. Data items are the molecules of the database. There are atoms and subatomic particles composing of each molecule (bits and bytes), but they do not convey meaning in their own right and so are of little concern to the users. These are called fields also. The data items grouped together are called records [4]. A program usually reads or writes whole records. Database Management System is a sophisticated piece of software which supports the creation, manipulation and administration of database systems. A database system comprises a database of operational data together with the processing functionality required to access and manage that data. The Database Administrator is the person responsible for the design, operation and management of the database. He or she must be technically competent, a good manager and possess excellent communication skills. Management skills are required to plan, coordinate and carry out the magnitude of tasks during all phases of database project and to supervise the staff. Technical skills are needed because DBA has to be able to understand the complex hardware and software issues involved and to work with system and application experts in solving problems. Diplomatic skills are used to communicate with users and determine their needs, to negotiate

agreements on data definitions and database access rights and to mediate between users with conflicting requirements. Excellent communication skills are required for all of these activities.

1.5 DATABASE MANAGEMENT SYSTEMS (DBMS):

In a traditional data processing environment, application and related data files and programs were developed in an unco-ordinated fashion. This resulted in hundreds of files and programs, great complexity, data redundancy, data inconsistency and high costs. Most importantly in this environment there was little ability to respond quickly and flexibility to ad hoc requests. Database management systems (DBMS) permit centralisation of data and data management. Database software includes a data dictionary capability, data definition language and data manipulation language. The most important feature of the DBMS is its ability to separate the logical and physical views of data. The user works with a logical view of data, which is translated automatically by DBMS software into a physical view. The DBMS retrieves information so that the user does not have to be concerned with its physical locations. This feature separates program from data. There are four kinds of logical database structures: hierarchical, network, relational and object oriented. Each has unique advantages and disadvantages. These are discussed in detail in second chapter.

1.6 TRADITIONAL DATABASES :

Traditional data is the record-based alphanumeric data handled by the file management systems. Great progress has been made in the development of database management systems capable of handling extremely large amount of data in a very flexible and fast manner. Yet these database systems have the disadvantages that they are limited to one medium only.

For example a database can not have as one of its fields a picture, a video film, an animation or a piece of sound, which are generally referred to as multimedia. Sound, video film, animation or graphics can not be converted into alphanumeric data easily. Even if they are converted, such conversion takes a large amount of time. So the traditional database is incomplete in capturing all information. The media other than alphanumeric data, such as sound, are much more interactive and user friendly so their absence makes the traditional databases very dull.

1.7 MULTIMEDIA DATABASES :

A multimedia system is a system which comprises of more than one medium. Similarly multimedia database is the database whose fields can have the values of more than one medium. Multimedia is a world full of excitement and rich in information content. Listening to a lecture leaves a much more better impression on us than reading from the book. Our grasping power is also more with listening than just reading. And if the graphics and animation is also combined with audio, the impression is ever lasting.

The applications of multimedia databases are numerous in many areas. One example of multimedia database may be the database of famous personalities of the world. Here in textual fields their date of birth, date of death, name, birth place and their important achievements can be stored. In graphical field their photographs can be stored. In video field the important incidents of their life times can be stored. In sound field their important speeches can be put. If such type of database is created the amount of information which it will provide will be enormous. It will be a very helpful for education of children. One more example where multimedia database is very relevant in the Indian context is the signature checking which is being performed in so many offices such as banks, post

offices etc. The time spent in retrieving signature, photograph, thumb impression etc to verify the authenticity of the user is quite large in the centers of banks and post offices. A multimedia database can significantly help in reducing the processing time of such operations.

The major hurdle in the multimedia field is the large storage requirement. All graphic files, video films and sound occupy a large amount of disc space. Because of this the multimedia applications are in the experimental stage. But gradually the multimedia applications are picking up. It promises the future of computing to be full of thrill, joy and excitement.

1.8 OUTLINE OF THE THESIS :

In this thesis an attempt to develop an experimental multimedia database management system has been made. The scope of the system is to provide the user a tool with which one can develop his/her own multimedia database. As a first step there are two media included in the package, text and bitmapped graphics. The other media such as sound, video or animation were not included because of limitation of computing facility and time. Second chapter covers a brief survey of literature. Third Chapter outlines the design features and fourth chapter details the implementation. Fifth Chapter lists the conclusions and suggestions for future work in this area.

LITERATURE SURVEY

2.1 TRADITIONAL FILE PROCESSING ENVIRONMENT :

Before the advent of database systems, computer-readable data was usually kept in files stored on magnetic tape or disk. In a typical file processing system, each department has its own set of applications and its own files, designed specifically for those applications. The department itself, working with the data processing staff, sets policies or standards for the format and maintenance of its files. For example, in a college environment, the admission office may have programs to track potential students and to generate letters and reports concerning their applications. The admission office decides what information will be stored, what data may be left blank in a record, what abbreviations will be used, how long records will be maintained, and when and by whom the file will be updated. Since it owns the file, this office also controls access to the information. A department chairperson who wants a list of names and addresses of potential students must obtain permission from the admission office for such a list to be generated. Eventually, the admission office forwards information about enrolled students to the dean and the registrar, both of whom have files of current students. If the information comes in the form of a printed report, all the data about each student must be re-entered. The registrar office 'owns' not only its file of current students, but also files concerning course offering, schedules, and so on. The dean's office may have its own student and course files, as well as faculty files. Faculty information is also kept by the personnel department, for use in payroll and other applications. In each case the file is owned by a particular department and others who need some of the information must either store it in their own files or obtain a printout by permission of the owner. Having

multiple copies of the same data (redundancy) leads to inconsistency, since different departments may have different data standards and update policies.

Figure 2.1 depicts such a traditional file system [3]. In this diagram the 'Accepted student data file', owned by the admissions office, is used in a matriculation program to generate a list of matriculated students. The 'Matriculated students data file' contains information about all active matriculated students. The 'Course data file' has information about the courses. These two files are owned by the registrar's office, along with a temporary file showing students' course enrollment requests, are used by a scheduling program to produce individual student schedules and class lists. The 'Dean's faculty data file' is used to assign a final teaching schedule to each professor. The 'Faculty payroll data file' has information needed for calculating pay and producing checks, payments and others payroll reports. Each program contains details of the physical structure and storage of the file it accesses.

2.2 INTEGRATED DATABASE ENVIRONMENT :

In contrast to the file processing environment, the integrated database environment has a single large repository of data, called the database, which is used simultaneously by many departments and users. Instead of disconnected files with redundant data, all data is stored together, with a minimum of repetition. Several different types of records may appear in the database, along with the logical connections among the data items and records. The database is not owned by a single department, but is a shared resource. It is managed by an individual (or group) called the Data base administrator (DBA), who is responsible for designing, creating, and maintaining a database to satisfy the needs of the users. The DBA interviews users to determine the data needs, examines the current system, analyses the organisation and its information needs and develops an

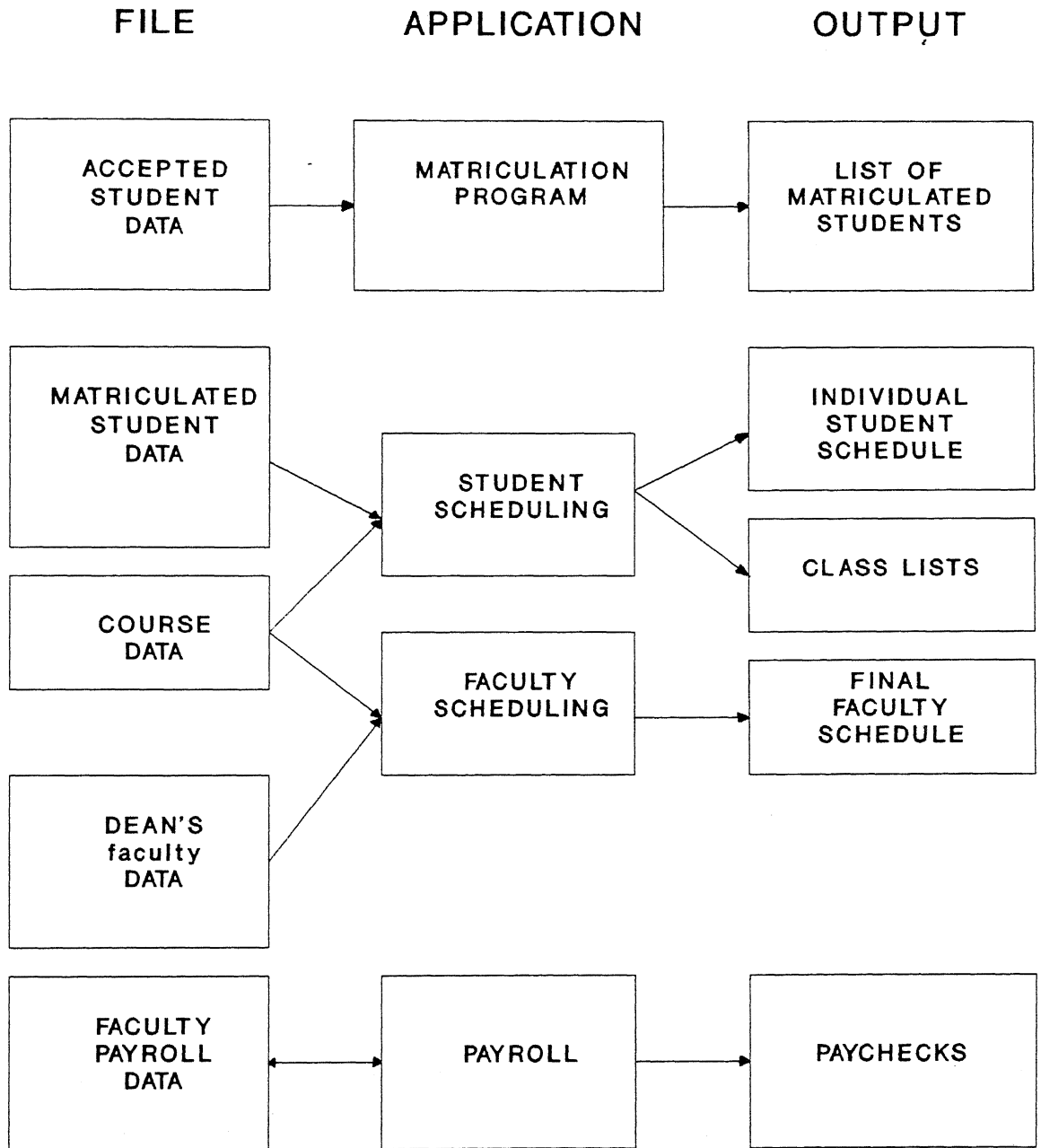


Figure 2.1 Traditional File System [3]

initial model for the database. The model is refined and improved as the DBA, in consultation with users, becomes more aware of their data needs and learns more about the functioning of the organisation. When a mutually satisfactory design is developed, the DBA implements it. Users are again consulted to determine whether the operation system is adequate. The design, redesign and refinements of the systems are all team efforts, with DBA staff and users working together to develop the best information system for the entire organisation.

All access to the database is controlled by a sophisticated software package called the database management system (DBMS). It has programs to setup the storage structures, load the data, accept the data requests from the programs and users, format retrieved data so that it appears in the form the program or the user expects, hide data that a particular user should not have access to, accept and perform updates, allow concurrent use of the data without having the users interfere with each other, and perform backup and recovery procedure automatically. These are just some of the many functions of a database management system.

Figure 2.2 demonstrates how the file processing environment of previous figure 2.1 would be modified in an integrated database environment [3].

Advantages of Integrated Database Approach :

(a) Unlike files, which are owned by the departments whose applications they serve, the database belongs to the entire organisation. The DBA manages the data, but it does not belong to any individual department. Many users can access the same piece of information. Thus the organisation has control over its data.

(b) The file processing system wastes space by storing some of the information in two or more files. While in integrated database the

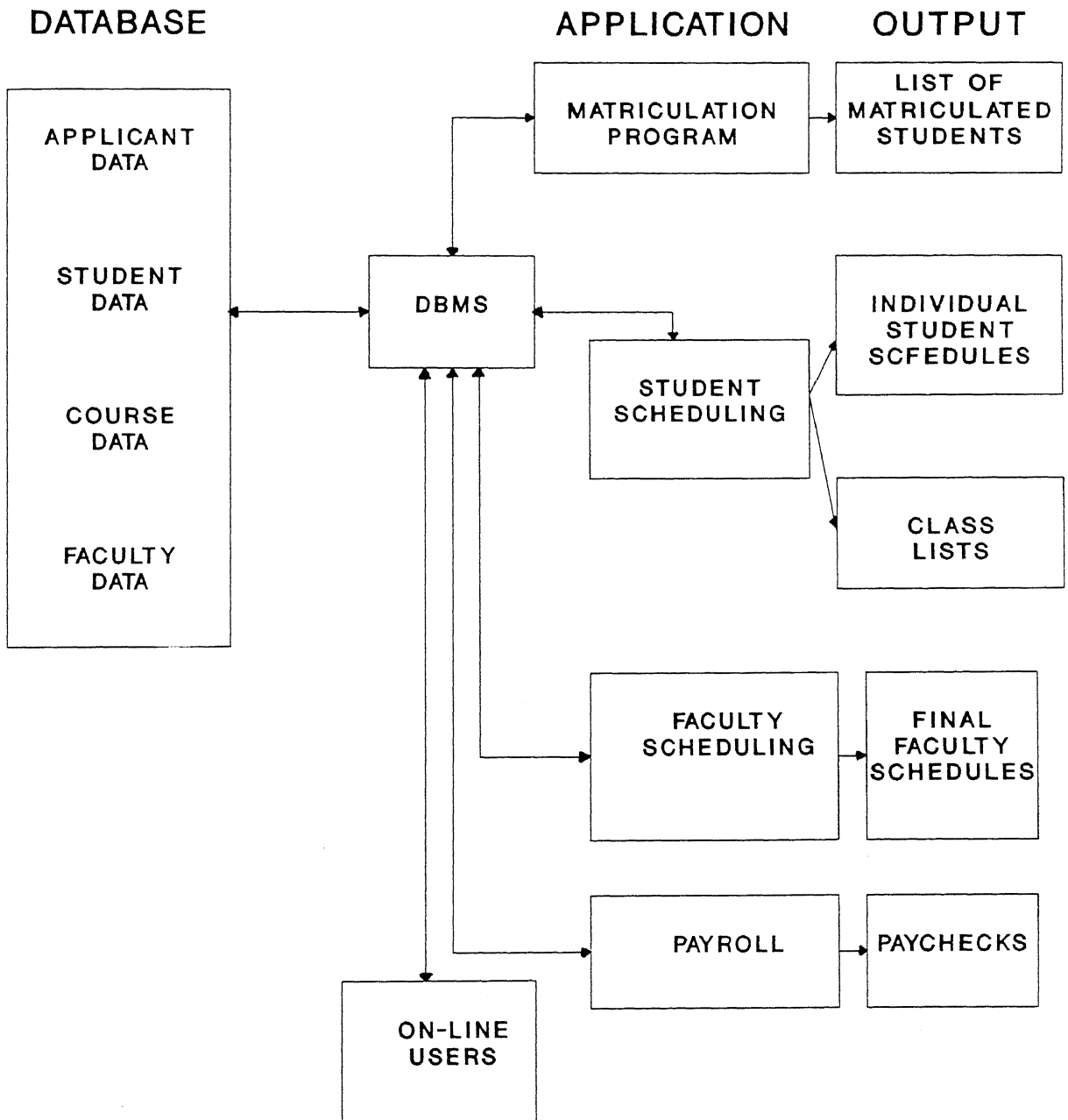


Figure 2.2 Integrated Database Environment [3]

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information is integrated so that several copies of the same data are not stored.

(c) One effect of eliminating or controlling redundancy is that the data is consistent. If data item appears only once, any update to its value needs to be performed only once, and all users have immediate access to the new value.

(d) Data security is performed through the DBMS, which can require that users go through security procedures or use additional passwords to gain access to data.

(e) Most database management systems allow on-line access of data by the users. They provide query languages that permit users to ask questions and provide the required information.

Disadvantages of the Integrated Database Environment :

(a) Because DBMS is a complete database management system it is expensive to purchase or lease.

(b) Additional memory and processing power may be required to run the DBMS, resulting in the need to upgrade hardware.

(c) Whenever the resources are centralised, there is an increased security risk. Since all the applications depend on the database system, the failure of any component can bring the operation to a standstill.

2.3 DATABASE ARCHITECTURE :

Databases can be viewed at three levels of abstraction. The levels form a three-level architecture and are depicted by three schemas, or three models. This permanent structure is called the intension of database, or the database schema, while the information stored at a given moment is called an extension of database, or a database instance. A database model is a collection of tools that may include a type of diagram and specialised

vocabulary for describing the structure of the database. The model gives a description of the data, the relationships within the data, constraints on the data and data semantics or meanings.

The database has three level architecture to separate the way the users think about it. The way users think about data is called the external view level. The way the operating system and the DBMS see the data is the internal or physical level. The internal level is the way the data is actually stored using the data structures and file organisations. However, there are many different users' views and many physical structures, so there must be some method of mapping the external views to the physical structures. A direct mapping is undesirable, since changes made to physical structures or storage devices would require a corresponding change in the external to physical mapping. Therefore, there is a middle level that provides both the mapping and the desired independence between the external and physical levels. This is called the conceptual level. Figure 2.3 shows the three level architecture of database systems [3].

2.4 DATA MODELS :

2.4.1 SEMANTIC DATA MODELS :

These models are used to describe the conceptual and external levels of data and are independent of the internal and physical aspects. In addition to specifying what is to be represented in the database, they attempt to incorporate some meanings or semantic aspects of data, such as explicit representation of objects, attributes and relationships, categorization of objects and abstraction of explicit data constraints. The entity-relationship model is one of the semantic data models.

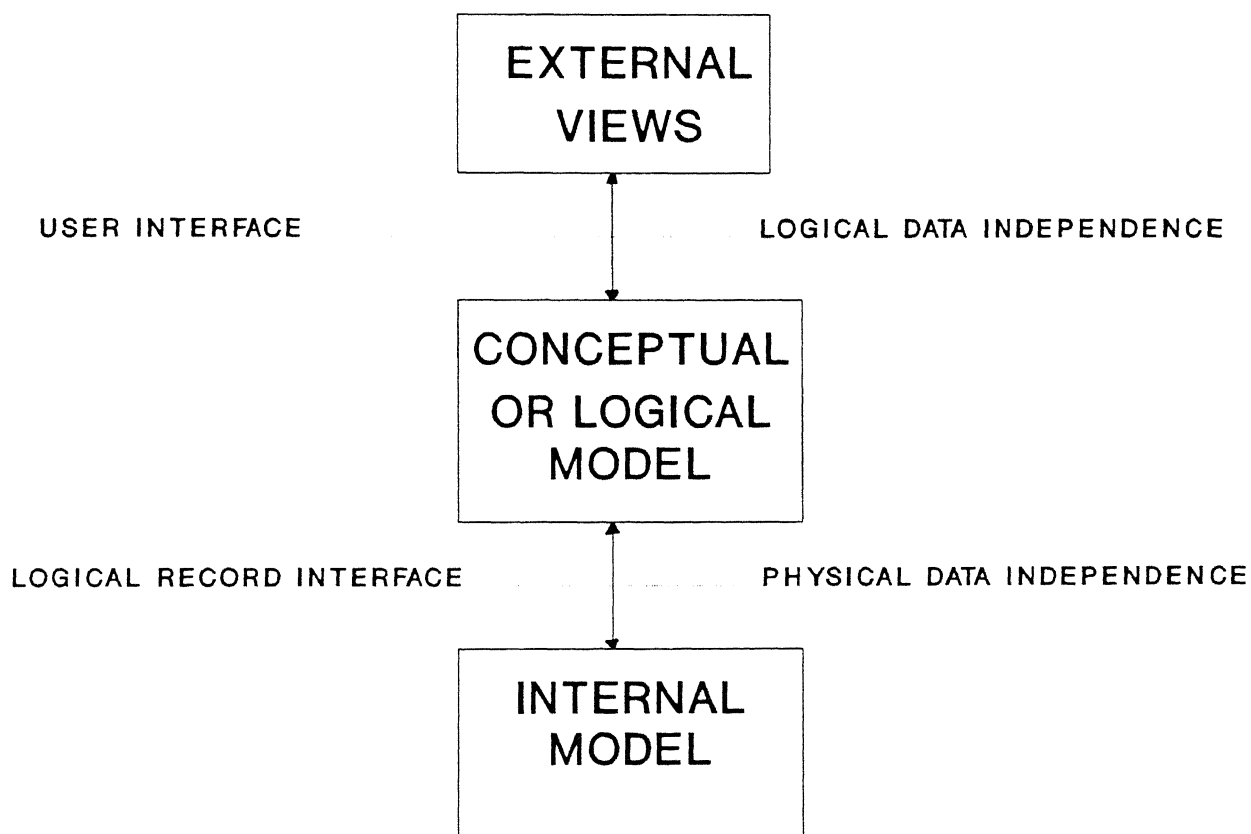


Figure 2.3 Architecture of Database Systems [3]

2.4.1.1 THE ENTITY-RELATIONSHIP MODEL :

This semantic model was introduced by Chen [8] in the mid-1970s and is widely used for logical design. It is based upon identifying real world objects, called entities which are described by their attributes and which are connected by relationships. An entity is any object that exists and is distinguishable from other objects. The attributes describe the entities and distinguish them from one another. An entity set is collection of entities of the same type. A relationship set is a set of relationships of the same type, And those relationships may themselves have descriptive attributes. The E-R model also allows to express constraints, or restrictions, on the entities or relationships. One of the most useful and attractive features of the E-R model is that it provides graphical method for depicting the logical structure of the database. E-R diagrams contain symbols for entities, attributes and relationships. Figure 2.4 illustrates a simple E-R diagram for students and classes [3]. It shows an entity set called 'student', with the attributes 'stuid', 'stuname', 'major', and 'credits'. There is a second entity set 'class', with attributes 'course#', 'ctitle', 'prof', 'shed' and 'room'. The two entities are connected by a relationship set, 'enroll', which has descriptive attribute 'grade'. The E-R model describes only a logical structure for the database. We do not attempt to describe how the model could or should be represented internally.

2.4.2 RECORD-BASED MODELS :

These models are used to describe the external, conceptual, and to some extent, the internal levels of the database. They allow the designer to develop and specify the logical structure and provide some options for implementation of the design. They have been implemented in a variety of database systems [3]. However, they do not provide much semantic information. Some of the record-based methods are given below.

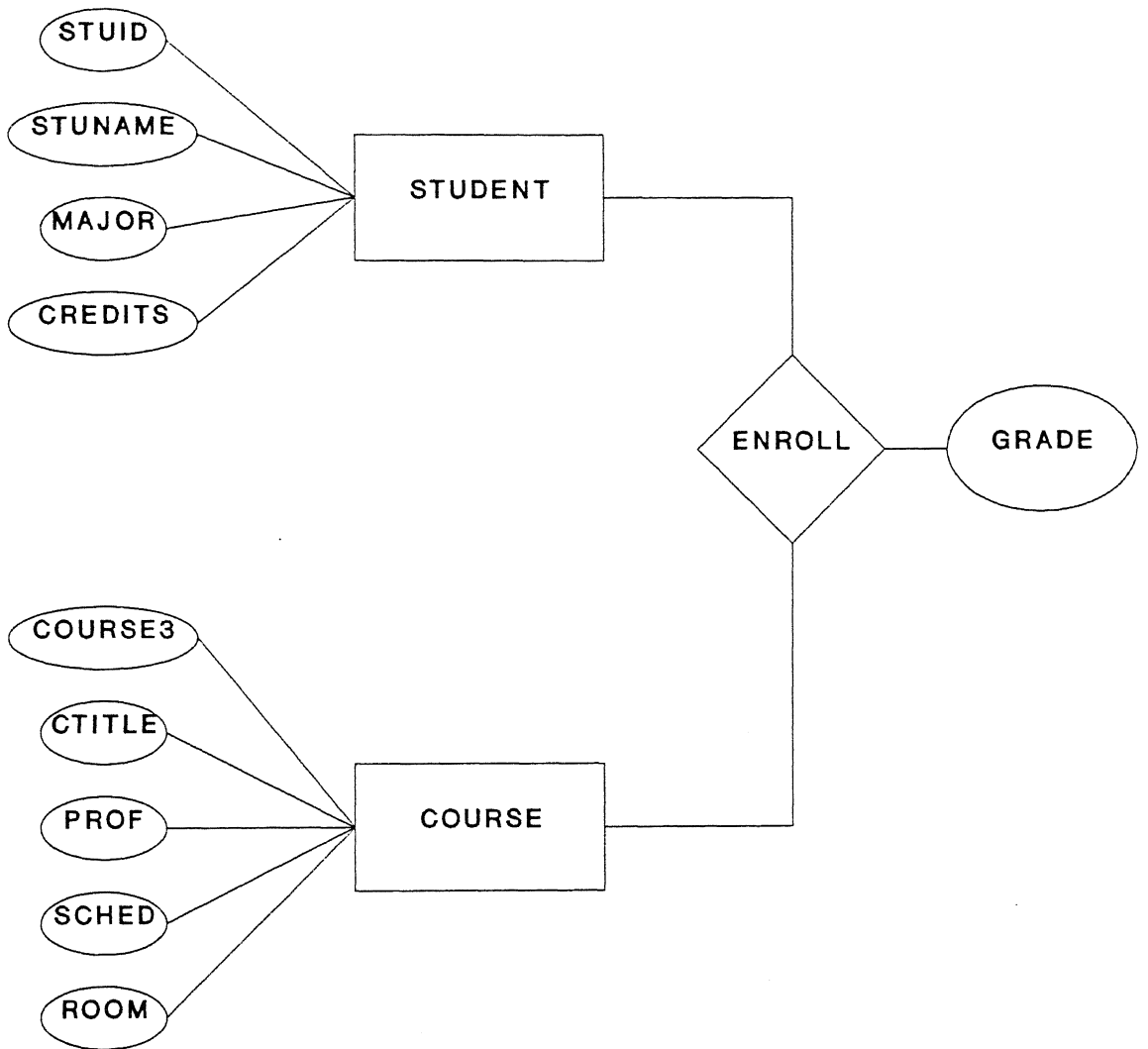


Figure 2.4 Entity Relationship (E-R) Diagram [3]

2.4.2.1 THE HIERARCHICAL MODEL :

The hierarchical model is the basis of the oldest database management systems, which came out of early attempts to organise data for the U. S. space programme. Since these databases were ad hoc solutions to immediate problems, they were created without the strong theoretical foundations that later systems had [3]. Their designers were familiar with file organisations and data structures and used these concepts to solve the immediate data representation problems of users. The hierarchical model uses the tree as its basic structure. Nodes of the tree in the hierarchical model represent data records or data segments, which are portions of data records. Relationships are represented as links or pointers between nodes. Figure 2.5 shows the schema or structure of a sample hierarchical database for the 'student' and 'class' data [3]. In this example the 'class' is root node and 'student' is its child. In an 'occurrence of' the structure, a 'class' segment may have zero one or many 'student' segments associated with it. To get to a 'student' segment one has to go through its parent 'class' segment. If a particular student is enrolled in more than one class, the student's ID, name, major and credits are repeated. There is no need for the separate 'enroll' record because the position of the 'student' segment, following its parent 'class' segment, tells what class the student is enrolled in.

2.4.2.2 NETWORK MODELS :

The network model uses a network or plex structure, which is a data structure consisting of nodes and branches [3]. Unlike a tree, a plex structure allows a node to have more than one parent. The nodes of the network represent records of various types. Relationships between records are represented as links, which become pointers in the implementation. Figure 2.6 shows a scheme of a network database for the student and class

CLASS

COURSE#	CTITLE	PROF	SCHED	ROOM
---------	--------	------	-------	------

STUDENT

STID	STUNAME	MAJOR	CREDITS	GRADE
------	---------	-------	---------	-------

Figure 2.5 Scheme of a Hierarchical Database System [3]

data. Here 'class' is a parent or owner record and 'enroll' is a child or member record. 'student' is also the owner record for 'enroll'. Each 'enroll' record represents the enrollment of one student in one class. In the physical implementation of this scheme, shown in figure 2.6, each 'class' record is the head of a circular linked list that goes through all the 'enroll' records for that class.

2.4.2.3 RELATIONAL MODEL :

The relational model was proposed by Codd [5] in 1970 and continues to be the subject of much research. It is now widely used by both mainframes and microcomputer-based DBMSs because of its simplicity from the user's point of view and its power. The relational model uses relations from the mathematics and adapts it for use in database theory. The same type of theoretical development of the subject, complete with formal notation, definitions, theorems, and proofs that we usually find in mathematics can be applied to databases using this model. The results of this theoretical development are then applied to practical considerations of implementation.

In the relational model, both entities and relationships are represented by 'relations', which are physically represented as 'tables' and attributes as 'columns' of those tables. For example, if we wish to store information about students and classes, we need a table for the student entity set, another for the class entity set and a third for the relationship between the student and class. A student is related to the class by being enrolled in that class. The columns of the 'student' table have headings for the student attributes: 'stuid', 'stuname', 'major' and 'credits'. The 'class' table has a column for each of its attributes, 'course#', 'ctitle', 'prof', 'sched' and 'room'. The 'enroll' table is used to show the relationship between the other two tables, by including the

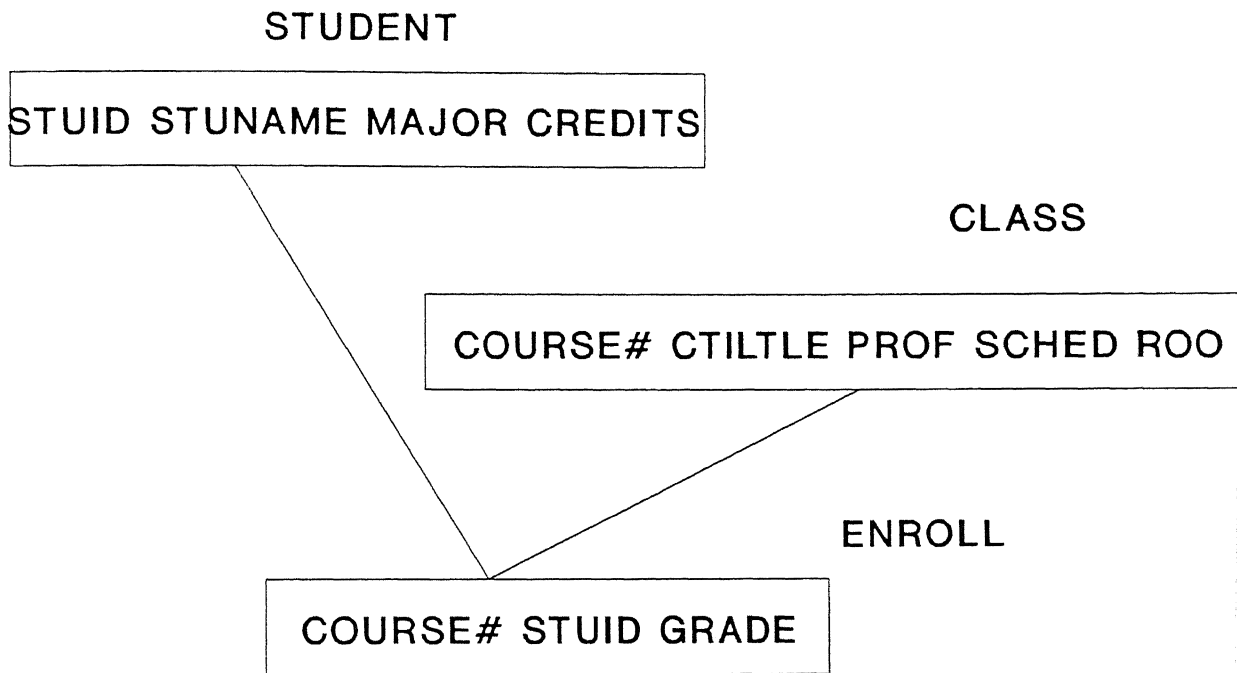


Figure 2.6 Scheme of a Network Database System [3]

columns 'stuid' and 'course#'. It also has the attribute 'grade', which belongs to the relationship.

2.4.2.4 OBJECT-ORIENTED DATABASES :

Recent research and development efforts have resulted in yet another generation of database technology: object-oriented database systems. These advanced systems, now beginning to appear as commercial products, provide further database management capabilities and address some of the limitations of relational and other record-oriented DBMSs. The characteristics of object-oriented databases are given below [9] :

(a) Abstract objects can be directly represented and manipulated in a database, independent of symbolic surrogates for them. Objects at various levels of abstraction and of various modalities can be accommodated.

(b) Primitives are provided to support object classification, structuring, semantic integrity constraints, and derived data. These primitive abstraction mechanisms support such features as aggregation, classification, installation and inheritance.

(c) Database objects can be active or passive, in the sense they can show the behaviour. The behavioral abstraction and encapsulation are supported, as well as procedures to manipulate the database.

(d) All information in a database is described using the same object model. Thus descriptive information about the objects, referred as meta-data, is conceptually represented in the same way as specific 'fact' objects.

The practical applications of object-oriented databases are CAD/CAM, AI, and multimedia office system.

2.5 MULTIMEDIA :

The last few years have seen the "birth" of multimedia. The

is always being dominated by the buzz words. Multimedia can sell, can teach, can entertain or can simply make the business presentation very exciting. In future every business application from spread sheets to electronic mail will reap the benefits of the multimedia [22]. With the appearance of the multimedia PCs in the market place this dream does not seem to be far away. These PCs come with CD ROM Drivers, advanced graphic displays and sound boards. Now-a-days interactive training and presentation applications are at the vanguard of multimedia's foray into business. The multimedia is the next big step in making the PC truly personal [22]. Instead of dull response to the commands using a command language the multimedia application can interact with the user giving them the random access to any part of presentation they desire. Such an application can also integrate animation, stereo sound, full motion video and cinematic effects. Multimedia has its roots in the traditional presentation programs such as Harvard Graphics. However creating an introductory multimedia application incorporating sound, motion and all the trimming is a much more complicated process than producing a typical self running, monitor based slide show and requires a much more powerful tool.

Multimedia is multisensory [28]. Both ears and eyes are influenced by multimedia applications. The multisensory problem is very tricky. Well integrated multimedia ensures a presentation with a wholeness that delivers a strong and clear message. But because of the presence of wide variety of technologies, people find it very difficult to learn even the popular multimedia system. Thus integrating several media for a presentation becomes a complex task.

DEFINITION :

Any combination of two or more media is called multimedia. The media may be text, graphics, animation, sound and video [28].

2.6 GRAPHICS AND IMAGES :

Graphics include line drawings, charts, signatures, logos, maps and so on. These types of data are stored in bitmapped form. Graphics are generally more "people friendly" than words or numbers and colour graphics have an even higher visual impact. From data processing point of view, colour triples the number of bytes to store the image. The term "image" is undergoing a change of meaning-it is broadening [33]. Formerly it referred to graphics that contained many shades of gray, generally called "halftones". The boarder definition of image refers to anything that is represented in a computer system in a bitmapped form-as opposed to a character or vector graphic form. Even with the use of compression, images require huge amount of storage. Another consideration while dealing with images is image manipulation-rotating an object, changing its scale, zooming in on parts, enhancing its quality by sharpening line edges and so on. Such manipulations require much more processing power than word processing and spread sheet manipulations.

2.7 SOUND :

Sound is another form of data. It is not static but contains time as one of its components. Sound also requires more storage than text. A word that can be stored in 4 bytes in character form requires 1000 bytes when stored in spoken form [33].

2.8 VIDEO INTERFACING OF COMPUTERS :

Video is images in motion. For full-motion video, the images need to change 30 times a second. The technical gap between the world of video and computing exists primarily because of difference in video recording

signals to those of computers [24]. The standard recording signals in both the United States and Europe don't match a computer's video signals. In the United States, the National Television Standards Committee (NTSC) dictates the standards of a playback recording requirement of 525 lines of resolution and 60 interlaced half frames per second. Europe's PAL standard requires a resolution of 625 lines. In contrast most computers have a frequency of 512 lines of resolution and 30 frames per second.

Getting the video to display on a PC workstation monitor is an architecturally tricky task of matching and mixing the computer's video signal with a motion video signal such as NTSC or Europe's PAL. Standards will have to happen to bridge the video and computers to complete. Today vendors are offering various types of add-on boards to bridge the video signal disparity and create systems that can display motion video, text and graphics on the same monitor. Some of these systems simply transfer the video on the screen; Others digitize the motion video in real time and merge it with the display memory. Now-a-days a new technology is also coming up i.e. Videodisc [24]. It is a laserdisc record that can contain computer data or audio and video signals. Videodiscs can be interfaced with computers to create interactive program. The system that links the two allows a computer to access and play any frame on the disc. Such a system would also enable graphics and text generated by the computer to be superimposed over the videodisc images.

2.9 CD-ROM AND MULTIMEDIA :

Multimedia applications are heavily dependent on CD-ROMs. Multimedia applications require the storage for high amount of digitized audio or video data [19]. CD-ROM's High capacity to store data and relatively low prices are the main reasons that render it the only practical medium fit for multimedia applications.

CD-ROM takes its roots from the physical structure of the audio CD [18]. CD-ROM sectors are arranged in continuous spiral tracks, not in concentric tracks as in hard disks or floppy disks. Because the data is stored in sequential way. It is good for reading large blocks of sequential data, such as music. But it makes for slower random access times than the concentric tracks used by hard disks, whose sectors can be located faster because they are always found on a given track at a fixed distance from the center. There is one more reason for its slower access. The length of sectors of disk on tracks continuously increases as the distance of tracks from the center increases. The angular rotation speed of disk is always fixed. But CD-ROMs have the constant sector length. It follows fixed linear velocity principle. Because of this the angular rotational velocity of CD-ROMs changes depending on the distance of the sector from the center. This requires a new complicated drive mechanism that can overcome the inertia of the disk when accelerating and the momentum when decelerating which in result slows the drive's random access time. But this encoding scheme for storage is used because it allows data to be packed at maximum density over the entire disk. Gradually the access speed of CD-ROMs is also increasing.

2.10 MULTIMEDIA PROGRAMMING :

Multi media programming occurs in the following three steps [28]:

- (a) Creating the multimedia delivery system itself.
- (b) Creating the content delivered by the multimedia delivery system (information authoring).
- (c) Creating the links and paths through the content (information structuring).

There are two types of contents: the information and the access paths. Thus making an interactive video disc proves much harder than making

a movie. For the movie is as the author thinks it to be. He has the option of conveying the message which he feels. He selects the start, the middle and the end. It is hoped that the user gets the message. But this is not true in case of interactive video disc. Here first the content is found out. Then one has to provide multiple access paths and indices so that users, with unknown goals can create threads, dimensions and perspectives that meet their goals. In effect, users can produce their own specific movies based on both the content and the access paths which producer provides. The key is having tools that allow people to navigate through information as they see fit. Otherwise, the tool maker imposes a message on the information that might not be the one desired by a given user. In creating a multimedia delivery system, we encounter the technical problem of how to provide a mechanism for allowing users to create particular goal directed structures that are not known in advance.

Finally we notice that our three multimedia programming stages appear in the order of increasing number of people involved [28]. Without breakthroughs in the first stage and authoring systems the succeeding stages do not matter.

2.11 HURDLES IN MULTIMEDIA FIELD :

(a) The major hurdle in the field of multimedia is the complex computer hardware which is being used by the multimedia application.

(b) The other difficulty is how to program the time. Time consists of two parts, real time and event sequencing. Real time as a computer, is not something that average computer users are accustomed to. It remains an obstacle. The sequencing part seems to be the familiar enough, but the notion of real time and the related synchronization of events (speech synchronization with lip movements or sound synchronized with graphics) do not. People who do video editing deal mostly with sequencing and the real

time sound and image synchronisation is amended in the clips. However in multimedia, as with graphic animation, this synchronisation must be created.

(c) Multimedia applications require a large amount of memory. So the storage space for these applications is a big problem.

(d) The multimedia lacks in standards, so the products manufactured by the different vendors are not compatible. It creates a problem for their adaptability in the market.

2.12 MICROSOFT'S CONTRIBUTIONS TO THE FIELD OF MULTIMEDIA :

Microsoft's contributions to the area of multimedia are so significant that these deserve a special mention. Microsoft is one of the most active members of Multimedia PC Marketing Council . The council consists of AT&T Computer Systems, CompuAdd Corporation, Creative Labs Inc, Media Vision, NEC Technologies, Olivetti, Philips Consumer Electronics Company, Tandy Corporation, Video Seven, Zenith Data Systems and Microsoft Corporation [16]. Except Microsoft corporation all the members of the council are hardware vendors. It is the sole software representative in the council.

Recently Microsoft proposed Multimedia PC hardware specifications. It is an attempt to bring the standardisation to the multimedia field, absence of which is causing a great harm to the field. The minimum MPC specifications as proposed by Microsoft are given below [16] :

- (i) CPU - 10 MHz 286.
- (ii) System Memory - 2 MB.
- (iii) Storage - 30 MB Hard disk, 1.44 MB floppy disk drive.
- (iv) Video Display - VGA.
- (v) Audio - 8-bit sampling, Music Synthesizer, MIDI-in/
MIDI-out, on board analog audio mixing.
- (vi) Optical Storage - CD-ROM with CD-Digital audio output.

(vii) Software - DOS 5.0, Microsoft Windows 3.0 with Multimedia extensions.

With the help of Microsoft's Multimedia extensions to Windows 3.0 now there is no need to write device drivers for using devices [25]. Using Microsoft's Multimedia development kit (MDK) one can write to the generalized media control interface using ordinary ASCII command strings or Windows' messages. For more detailed control, one can use lower level services for applications involving CD Audio, Autodesk animator movies, joysticks and videodisks.

2.13 MULTIMEDIA ELECTRONIC MAIL :

Text only electronic mail (E-mail) is a widely used and increasingly appreciated medium for the inter personal communications. As such it is clearly a technological success story. For many years researches have sought to extend and enhance this successful technology by augmenting it to permit the exchange of multimedia messages. Multimedia E-mail can permit correspondents to exchange formatted texts, pictures, animation and video clip pets and more. Yet despite years of interest and a number of highly visible and usable prototypes, multimedia E-mail has failed to achieve widespread use. The present condition of multimedia E-mail is also due to the lack of standards in the technology [26]. But its wider usability is still very attracting to a large number of researchers and a number of proto-types are still being built.

2.14 LATEST MULTIMEDIA PRODUCTS :

Presently almost every day new multimedia products are coming up. There seems to be a cut throat competition among the hardware and software vendors to produce the new multimedia products. Following is a survey of some of the important new multimedia products.

Computer and software vendors have been struggling to add multimedia features - graphics, sound, animation and CD-ROM drives to personal computers. But for a long time multimedia has been more promise than a reality, in part because we had no standards for this technology. The simultaneous introduction of the Microsoft-endorsed multimedia PC and IBM's Ultimedia strategy has finally brought some standards to the market. These two products are discussed in detail in coming paragraphs.

2.14.1 IBM'S ULTIMEDIA :

The IBM PS/2 Ultimedia model M57 SLC is a mix of excellent components whose sum may be less than the individual parts [14]. The machine has an enhanced 386X processor, 16-bit audio from a new version of IBM's M-Audio capture and Playback adapter/A (ACPA/A), IBM's CD-ROM II with CD-ROM/XA (extended architecture), Digital video interactive (DVI) support and an advanced internal speaker that eliminates the need for separate speakers. These features are added to the existing XGA graphics, built-in SCSI controller and high capacity 2.88MB floppy disk drive found in IBM's PS/2 model 57.

Together, all these parts create an excellent engineered multimedia PC. IBM sees its OS/2 ver 2.0 with its multimedia presentation manager as the superior multimedia environment because OS/2 has 32-bit multithreaded capabilities and the ability to bus-master devices. In fact, IBM enables one switch to DOS 5.0 and ultimedia PC under OS/2. The sound generated from IBM's enhanced internal speaker is enough to fill a large room for presentation. The speed and colour of IBM's XGA graphics is commendable, and the seek and throughput performance of its CD-ROM/XA is top-notch. The performance will be even faster with IBM's 386 SLC CPU present. IBM sees the ultimedia as a serious business machine and authoring tool for multimedia presentations.

2.14.2 MULTIMEDIA PC FROM TANDY :

As one of the driving forces on the MPC council, the Tandy has produced the first Multimedia PC [15]. Microsoft Windows is the operating system. Compared to previous Tandy/Radio shack home systems, the 4033 LX is impressive, although costly. The \$5,499 4033LX multimedia comes complete with a 33-Mhz processor, 4 MB RAM, a 105 MB IDE hard disk drive, super VGA, Windows 3.0 with the multimedia extensions, and DOS 5.0. The 4033 LX machine is the top of Tandy's line of multimedia PCs which start with a 16 and 25 MHz 386DX systems. Rounding out the multimedia package offered by the 4033 LX is Tandy's own internal CDR-1000 CD-ROM drive and the sound Blaster pro audio card developed by Creative Labs. Tandy also includes a CD-ROM based welcoming tour of the system's multimedia capabilities. The speed of accessing the data on this machine is not fast. Tandy's CD-ROM drive delivers a throughput of 146.96 Kilobytes per second on sequential reads from a compact disc, but delivers a throughput of under 70 KBps in random reads. The 4033 LX demonstrates the potential for the multimedia computing. If Tandy improves over the performance of its CD-ROM drive, this potential will become reality.

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2.14.3 MEDIAVIEW :

Mediaview is a multimedia digital publication system that was designed to be flexible and free to take the maximum advantage of the media-rich hardware and software capabilities of the Next computer, especially the features of the NeXTdimension subsystem [13]. Rather than emphasize the work that is almost always paired with multimedia, 'presentation' Mediaview emphasizes communication. The system does not tacitly impose the "publisher's" agenda on the reader, but structure and sequencing can be overlaid if appropriate. The result is a very general system free of artificial structure and inconvenient metaphor. Mediaview is

easy to use and understand. It is based on the what-you-see-is-what-you-get (WYSIWYG) word processor metaphor, familiar to most computer users. In addition to text, that metaphor is extended to include several multimedia components. And like text, these components are subject to the select/cut/copy/paste paradigm making them as simple to manipulate as words. Consequently powerful and complex MediaView documents can be constructed by non specialists. Additionally, any thing MediaView displays on the screen can be printed, or can be captured as a PostScript or TIFF file for processing by the other applications. In addition to the expected multimedia components such graphics, audio and video, MediaView supports several non traditional components. These include full-colour images; object based animations; image-based animations; mathematics; and customised, dynamic loadable component.

2.14.4 IconAuthor :

IconAuthor is a multimedia authoring system. It is one of the very first packages which make use of the power of Microsoft's Multimedia Extensions [17]. In addition to orchestrating the flow of a multimedia piece, IconAuthor provides the tools for creating and editing graphics and animation sequences. To further embellish one's work, one can take advantage of its support for an arsenal of hardware including full-motion video, digitized audio, synthesized music and material accessed from CD-ROM or audio CD.

DESIGN

3.1 DEVELOPMENT STRATEGY :

The development strategy was to build an experimental multimedia system in a modest way. We wanted 'completeness' in the sense of being able to include both the data-definition and data-manipulation capabilities. However the security and recovery features were kept out. The system being a modest first attempt, we wanted to extend traditional database management systems to include just one more medium. The choice was among bitmapped graphics, audio, video and animation. Thanks to the availability of HP ScanJet scanner and the non-availability of audio and video cards, we limited ourselves to the inclusion of bitmapped graphics. HP ScanJet being a non-colour scanner, we were limited to monochrome images only. Even this inclusion posed enough challenges in implementation; it offers a lot of application avenues as well to make the implementation sufficiently interesting. Bitmapped graphics take a lot of disk space. Though enough compression schemes are available they do not necessarily mitigate the disk space problem substantially. Many of the compression schemes are non-standard; so their usage unduly limits the implementation. Since our goal was to demonstrate the functionality, we used the Bitmap (.BMP) format of scanned images, as this format is readily handled by Windows 3.0. A natural extension of 'Disk hungry' nature of bitmaps is the limited storage capability of records. Hence we do not use any indexing schemes for record access. Even though search functionality will be provided to the application, the actual search mechanism will be sequential. For a small database this does not pose any problems.

3.2 HARDWARE CHOICE :

We had intended to build the system on a PC platform. Multimedia applications being very demanding on the processor we decided to use a 386 based PC. For scanning the images we use either a Logitech hand held scanner or a HP ScanJet scanner. HP scanner being a flat bed scanner the scanned images are much better. Both offer a choice of resolutions ranging from 75 to 300 DPI. Depending on the image we adopt a scanning resolution fitting the application. The lower resolution permit us to handle larger images and the higher resolution permit sharper but much smaller size images. For user-interaction we preferred a mouse with a "point and click" feel that fits the multimedia applications much better.

3.3 SOFTWARE CHOICE :

We need to handle and manipulate bitmapped images. Naturally a windowing interface was a must. The obvious choice on a PC platform was to use Microsoft Windows 3.0. MS-Windows provide an intuitive graphical user interface and supports the mouse. It also has built-in utilities (like paintbrush) to handle images. HP scanner images kept in Scan Gallery can also be manipulated using Windows.

We needed to program windows. We had the option to choose among MS Windows Software Development Kit (SDK), Visual Basic and Borland C++. The later one is far less expensive and support object management (for later use). Hence we decided to use Borland C++ for development.

3.4 USER INTERFACE :

Being an experimental tool we decided to provide an intuitive and visual interface to database. Since the underlying databases are expected to contain just a few records, the power of visual interfaces can be demonstrated without undue inefficiency. This fits within overall policy of

multimedia database, PC platform, Windows software and mouse as a pointing device. To fully exploit the visual interface to database we use all the features of Windows environment viz icons, windows, menus and dialog boxes.

3.5 DATA MODEL :

The physical and logical database structure used for storing the records is relational in nature. The data is stored simply in the form of tables. The rows represent the different records and the columns represent the different fields. Relational model is elegant, easy to manipulate and is backed by a well developed theory. Since our main goal is to demonstrate a functionally working system, we limited ourselves to the following data types as possible fields: character strings, integer and bitmaps. Other data types such as date, logical and memo were excluded from the implementation at this stage.

As mentioned earlier data manipulation is limited to simple queries that are generated using an intuitive visual interface. No general purpose queries expressed in a command language are processed. For small size databases this limitation should not pose any major constraint, in our opinion.

IMPLEMENTATION

4.1 ARRANGEMENT OF FILES :

The structure of different files used by the package is shown pictorially in figure 4.1. The package is the form of a batch file. This file has the following three components :

- (a) The main program in Borland c++ (MULDB.EXE).
- (b) Another batch file invoked under this batch file (MCOMP.BAT).
- (c) Calling the MS Windows 3.0 (WIN.COM).

The main program creates new application database file or uses an existing file in the database. It can modify (including delete) any of the existing application database files. If user wants to use an existing application database file, it opens a file named 'MREC.MRC', containing the application database files which are there in the DBMS. The list of database files available is shown to the users and the user is required to choose the relevant file, he wants to use. Depending on the user's choice the particular database file is opened. All the application database files have '.MRC' as an extension. All of these files have the data in fixed format. All the data from these files is read into the RAM. The modification in the fields and records can be done in this program. Once user finishes with the addition, deletion or modification of fields or records, the data is again written back in the same database file. Depending on the data the main program generates three files which are required to make a Windows executable file. These three files are listed below :

- (a) Main C application file (MULDTB.C).
- (b) Module definition file (MULDTB.DEF).
- (c) Resource script file (MULDTB.RC).

The second BAT file (MCOM.BAT) which is embedded in the main BAT

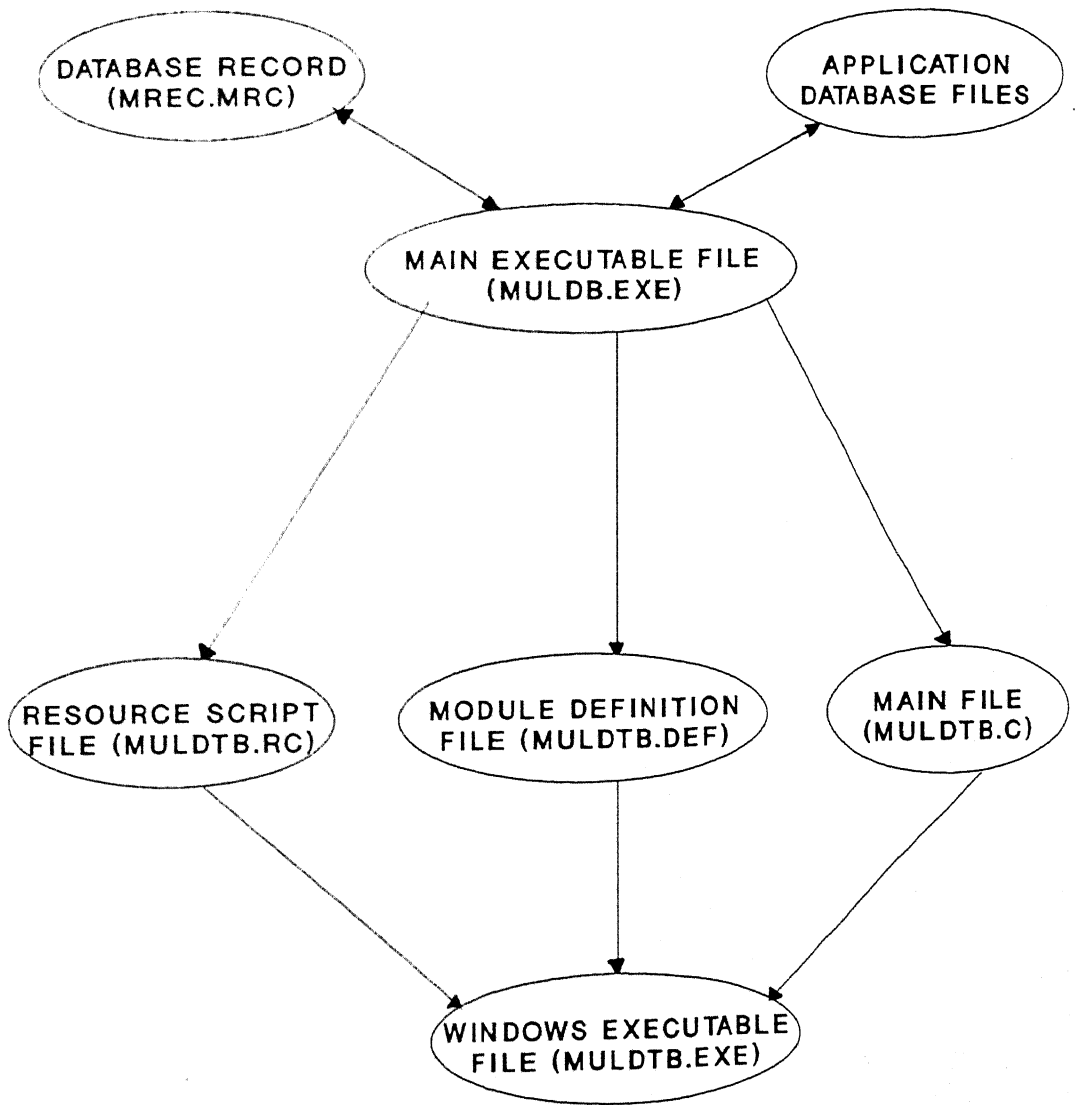


Figure 4.1 Structure of Files

file is required to compile these three files to make a Windows executable program. Compilation is done by using command line compilation option. The path of Borland C++ 's Library and Include files is given in this file. In case the path is changed it should be specified in this file for successful compilation.

Finally the Windows are called and the Windows executable file is run under it.

4.2 STRUCTURE OF APPLICATION DATABASE FILE :

All the application database files have a uniform structure for compatibility. The first line of the file has the number of fields in the file. The second line has the nature of different fields listed in the sequence as given by the user. The third line has the widths of different fields listed in the sequence. The fourth line has the name of different fields written in the order. The fifth line has the number of records in the file. After it there is one line per record. In a record line the different field values are written in the fixed order of their field number.

4.3 MANIPULATION OF FIELDS :

In a given file the new fields can be added or can be deleted. The information such as the name, width and nature of the different fields are kept in different arrays. Whenever a field is added, it is added in the end only and different values about it should be given by the user. Whenever a field is deleted all the succeeding fields are shifted to the beginning by one field.

4.4 ADDITION, DELETION AND MODIFICATION OF RECORDS :

Every field value of a record is having structure as 'union'

'union' one is character string and other is integer. If the field is either character string or a graphic field it is stored as the character string. If the field value is integer then it is stored as an integer. The records can be added only at the end while any record can be deleted. If only some of the field values have to be changed then the modification option is chosen.

4.5 DISPLAY AND QUERY ON RECORDS :

The display of records and the query on records is done under Windows. As soon as the Windows program starts the opening screen has the TiledWindow with caption "MULTIMEDIA DATABASE". It has three menu items, "SHOW RECORDS", "QUERY INFORMATION" and "SEARCH". Besides the main window there are some other small windows also having zero width and zero height. Their number is equal to the number of graphic fields in the database file. These small windows are also of type TiledWindow. These windows are having the option of resizing so they can be moved, iconised, reduced in size, increased in size and can be zoomed to fill the whole screen.

When user clicks the mouse over the first menu option i.e. "SHOW RECORDS", a dialog box appears which prompts for the further display of records or for the termination of this process. The dialog box used is modeless in nature so as to be able to transfer the control between the dialog boxes and different windows. When user opts for the second menu item i.e. "QUERY INFORMATION", a dialog box again appears. It is a modal dialog box i.e. whenever it appears on the screen first input has to be given strictly to this box. If user tries some other outside the dialog box it gives a beep. The third menu item uses again a modeless dialog box. If user chooses the 'close' command from the system menu of any window the 'PostQuit' message is sent to Windows which terminates the program. It

reduces the user's efforts otherwise he has to close all the windows one by one.

4.6 USER'S MANUAL :

This section provides the user all the details for using this experimental multimedia database management package (MMDB). By the use of this package the user can create a database file, can use an existing database file or can delete an existing database file in the package. The distinctive feature of MMDB is that one of the fields in the database file can be a graphic field. Though the instructions given in this manual are general one but the user is requested to go through it, before using the package so as to run the package smoothly. The flowchart shown in the figure 4.2 will also be useful in this purpose.

4.6.1 REQUIREMENTS :

HARDWARE REQUIREMENTS:

The following are the hardware requirements for the package. PC AT with 386 processor with 2 MB of RAM (co-processor is not needed) , at least 3 MB of disc space and a mouse. Any of the adapters CGA, HGA, EGA, VGA can be used. In case the graphic file has to be taken from the paper media a scanner is needed. Any type of scanner hand held ,flat bed or roller can be used for this purpose.

SOFTWARE REQUIREMENTS :

The following are the software requirements for the package. Microsoft Windows 3.0, DOS 4.0 or some higher version and Borland C++ compiler. If graphic files are to be taken from the paper media,

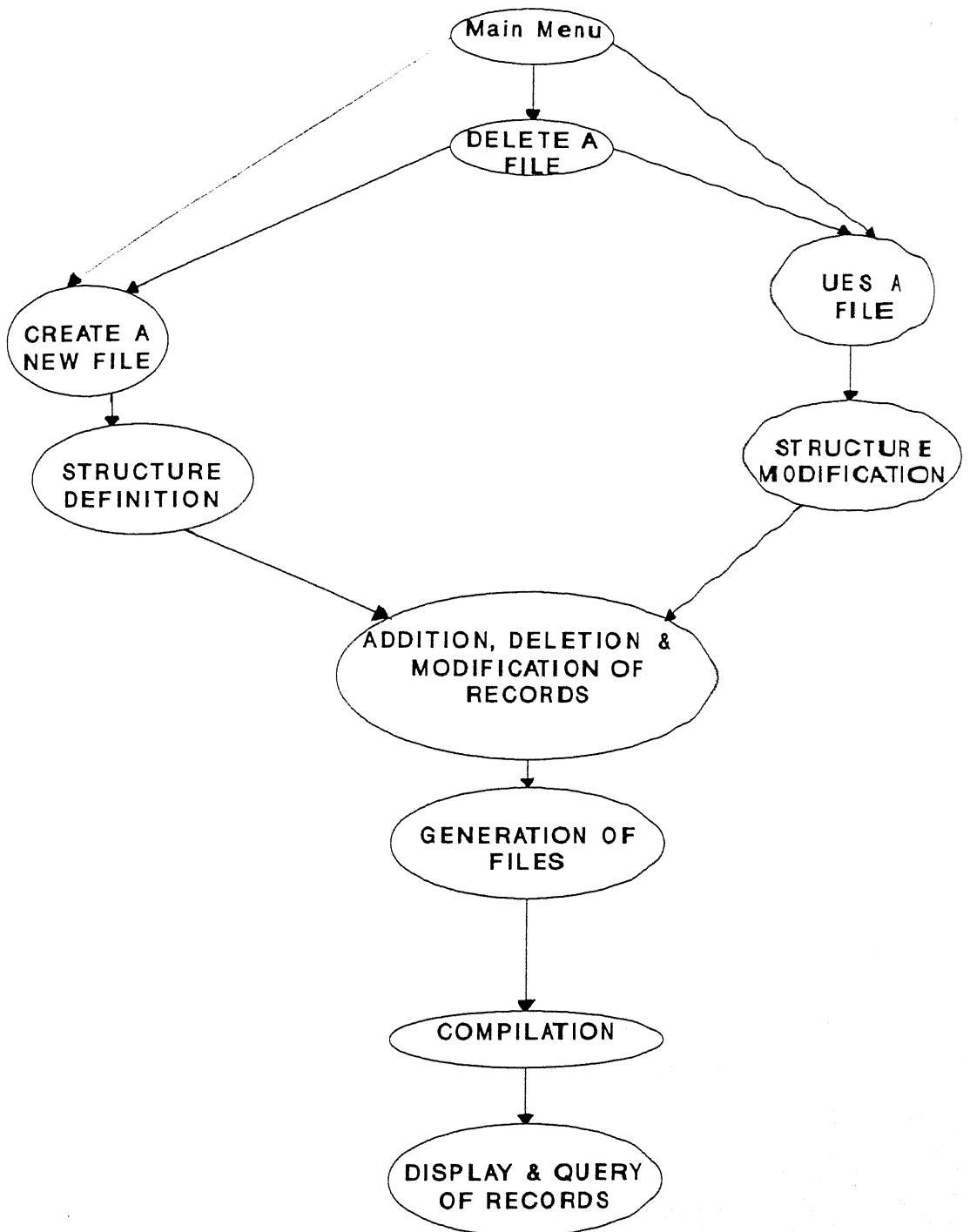


Figure 4.2 Outline of Main Program

'PCX' (PC Paintbrush) format or in '.BMP' (Microsoft Windows Bitmap) format.

USER'S BACKGROUND :

Since the package runs in DOS as well as in Microsoft Windows operating environments. The user should have a minimal knowledge of both of these environments. He is further required to have some basic knowledge of database systems also.

4.6.2 GUIDELINES FOR USING THE PACKAGE :

The package is in a 'BAT' file. Its name is 'MDATB.BAT'. The directory which contains this file should have 'MCOMP.BAT' and 'MULDB.EXE' also. While running the package 'WINDOWS' should be in the path. Start the package with writing 'MDATB' at the prompt. As soon as the program starts a fresh screen appears with 'MULTIMEDIA DATABASE' written at the top. Below it is given the list of database files currently in the package. At this stage there are three options :

- (a) Creating a new database file.
- (b) Using an existing database file.
- (c) Deleting an existing database file.

The user has to choose one of the options. Depending on it the program proceeds. These options are discussed further in detail.

(i) CREATING A NEW DATABASE FILE :

As you choose the first option, the package prompts for the name of new database file. The user has to give the name of file. The file's name should be maximum of 8 characters without any extension. The package on its own gives the extension '.MRC'. Then program asks for the number of

prompts the user for information regarding the specific fields. The nature of the fields can be Integer, Character string or Graphic. If the field is Integer or Character string then it asks for the width of the field also. Once the information about the fields is finished. The next step is about the manipulation of records. It is discussed in detail in the following sections.

(ii) USING AN EXISTING FILE :

In case you choose the option as 2 on the opening screen of program, the program further prompts for the number of database file to be used. Depending on the choice particular file will be opened. The structure of its fields will be shown on the next screen. At this screen itself the user is prompted for the modification in the field structure. In case user goes for the modification, the field structure is modified. Further package prompts for the manipulation of records. Later the display of records and query on records is done in the Windows. These steps are discussed in detail in following sections.

(iii) DELETING AN EXISTING FILE :

If the user chooses the third option at the opening screen, the program prompts for an existing file to be deleted. After deleting the user specified file. The Opening screen reappears. At this stage again the user has to choose either the first option or the second option to continue.

4.6.3 MANIPULATION OF THE FIELDS :

At this step the user is prompted for adding or deleting an existing field. If you want to add a field, first the name of the new field is prompted. The field name should not have any blank spaces. later the

character or integer the width of the field is asked. For graphic field there is no need to give the width. Now the user is required to fill the values in the existing records for the new field.

In case the user wants to delete an existing field the program prompts for the user response based on which that particular field is deleted. The information contained in the records for the deleted field is also lost.

4.6.4 MANIPULATION OF RECORDS :

For manipulating the records there are three options available. User can add a record, delete a record or modify an existing record. If user opts for addition of a record, the field values for that particular record are asked one by one. The user is required to fill it. For graphic field the name of file having the image should be given. The image should be in '.BMP' format only. While giving the name of file the '.BMP' extension should not be given. It is implied. If the file is in '.PCX' format it should be converted into the '.BMP' format. For details refer to 4.2.6.

If user opts for the deletion of a record, the program asks for the number of record to be deleted. Once the user gives the number of record, the information contained in the different fields for that particular record is lost.

If user wants to modify only some of the field values for a particular record the third option i.e. modification of records should be chosen. Once user goes for this option the number of record is asked. Now the program gives the field values one by one for that record and keeps on asking whether the value should be changed or not. In case user opts for 'yes' the new value is asked. Once the new value is given, it replaces the

The whole record manipulation loop keeps on iterating until the user opts for no modification option.

4.6.5 DISPLAY AND QUERY OF RECORDS :

Once the structure of fields and the information in the records are determined, the program shifts to Windows environment where the existing records can be displayed and the query operation can be performed. On the screen one big window and some small windows appear. The number of small windows is equal to the number of graphic fields used by the database file. Each window will be showing the information about one of the graphic fields. These windows can be resized and moved to any place as desired by the user. These windows can be iconised also. On the screen there are three menu items:

- (i) Show records.
- (ii) Query information.
- (iii) Search.

If user opts for the 'Show Records' option the records are started to be displayed in a sequential manner in the order in which they are stored. If the record displayed is not the last record a dialog box appears at lower left hand corner of the screen asking the user for further showing the record or exiting the current displaying of records. If user clicks the left mouse button at the 'NEXT' button, the next record is displayed. If user clicks the 'EXIT' button the displaying of records is stopped. While displaying if some of the graphic field is having the image size bigger than the Window's dimensions then the window can be zoomed up to the full screen. Later it can be again resized to the former size. If some of the graphic field user does not want to appear, its window can be iconised.

For carrying out the query operation on the records the user first

clicked a query dialog box appears. It has in one box the name of fields and in other box the different equality and inequality signs to be used with the fields. At the lower portion of the box there is an edit box where the text has to be put with the help of keyboard. At a time the query can be carried out on one field only. First select the name of field to be chosen to carry out the query, then select the sign. Now the character string or the integer with respect to which the query has to be carried out, will be put in the edit box. At last the 'OK' button is clicked. In case the user want to abandon the operation the 'CANCEL' button has to be clicked. With integer fields all the signs can be used for query. But with character fields only the equality sign can be used. The query operation for the character fields is not case sensitive. Once all the information required for the query is complete, the user should click on the 'SEARCH' menu item. As soon as the user clicks on it, the display of records one by one starts. These records are those records which satisfy the condition of the query. In case there is no such record which can satisfy the query a message box appears giving the message that no record is found.

For ending the package the user has to close any one of the windows and the program will be finished. While running the package if it starts behaving unpredictably the user should press 'ctrl-break' to terminate the BAT file.

4.6.6 CONVERSION OF '.PCX' FILES INTO '.BMP' FORMAT :

The '.PCX' files are converted to '.BMP' format with the help of Windows Paintbrush program. First the paintbrush program is started. Then the 'EDIT' menu item is selected. In it 'PASTE' command is selected. As soon as it is selected, a dialog box appears. The proper directory and the file should be selected which contains the '.PCX' file. With it the file is opened on the paintbrush screen. Now the 'FILE' menu should be selected, i

it the 'SAVE AS' command should be invoked. Again a dialog box appears here the user specifies the directory and the name of file to be stored in the '.BMP' format. The '.BMP' should be put at the end of the file name.

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION :

In this thesis an experimental multimedia system on a PC based hardware, running under Microsoft Windows 3.0 has been developed. Even though we limited ourselves to bitmapped graphics as the additional media in addition to traditional databases, we find the system fascinating enough with a variety of applications. Since both the data definition and data manipulation aspects have been implemented, the user can fully experiment with all the phases of multimedia database management system.

5.2 RECOMMENDATIONS FOR FURTHER WORK :

An immediate extension of the work submitted here is to look for efficient data compression schemes to store bitmaps. This would enable large database records to be handled.

A future extension to sufficiently enhance the scope of the work is to include the other media like sound and video as field types. While such implementation is indeed exciting it is considerably difficult as well.

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